

Econometric Model of Poverty for the Farming Households in Nigeria: A Simultaneous Equation Approach

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Abstract. This study examined the influence of some economic variables on poverty among the farming households in Nigeria using the Two-Stage Least Squares estimation method. The critical determinants of poverty among the respondents were found to be technical efficiency, per capita income, farm size, age, dependency ratio, household members working, household membership of farmer association, household food expenditure, per capita expenditure, access to markets, extension contacts, education, allocative efficiency, economic efficiency, total income, transfer income, household size, farming experience, non-food expenditure and gift/tax. Poverty can be reduced among the respondents by improving the respondents' farm efficiencies, scale of production, per capita income, food security, organization of farmers into collective farmers' institutions and household income distribution. Furthermore, increase in employment opportunities of the farming households, increase in farmers' access to markets, availability of extension services and increase in the access of farmers to higher education would reduce poverty among the respondents.

Keywords: Econometric model, poverty gap, determinants of poverty, farming households

1. Introduction

The issue of poverty alleviation is recently emerging as a major subject of concern in national and international policy discourse after many decades of its relegation to the background. As pointed out by Angaye (2005), poverty is engulfing more and more of the world's human population. According to him, the number of the poor in the world stood at about 1 billion in 1994, 1.3 billion in 1995, 1.74 billion in 1996, 2.04 billion in 2000, 2.56 billion in 2002, and has continued to increase despite all developmental effort put in place by both the government and non-government organizations (NGOs) to eradicate poverty. While the numbers of poor in the advanced countries of the world has reduced considerably over the years, the reverse is the case with the developing countries (Nyong, 1999). Poverty in developing countries takes various forms including low nutritional status, low level of education, decline in spending on social services by the government, high percentage of household income spent on food, high infant mortality rate, low level of savings, low level of investment, low absorption capacity, poor stage of quality and quantity of infrastructural development and low level of productivity.

According to Federal Republic of Nigeria (2005; 2007), poverty in Nigeria is a phenomenon where agricultural activities are most predominant. Poor households are more in agricultural occupation (62%) than in non-agricultural occupation (54%). The gap in poverty level of farm households and non-farm households was at 9%. About 56% of farmers living in the urban areas were poor, while about 63% of those in the rural areas were poor (Federal Republic of Nigeria, 2005). Twenty-five percent (25%) of the core poor households were in agriculture while 20% of the core poor households were in non-agricultural activities. Furthermore, 37% of non-poor were in agriculture and 63% of moderately poor were in agriculture.

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Agriculture has been focused as a central element of poverty reduction strategy in Nigeria (Federal Republic of Nigeria, 2005; Federal Republic of Nigeria, 2007). It is, therefore, important to understand the factors responsible for poverty among the farming households especially the smallholder farmers in Nigeria. Considering the fact that poor households are more in agricultural occupation and given the worsening status of poverty among the farming households in Nigeria (Federal Republic of Nigeria, 2005; Federal Republic of Nigeria, 2007), it has therefore become necessary to undertake this study. The main objective of this study therefore, is to formulate an econometric model of poverty for the farming households in Nigeria through a simultaneous equation model approach. The hypothesis that the included explanatory variables in the model have no significant influence on poverty was tested.

2. Methodology

For this study, farm level data were collected from smallholder farmers in Benue State, Nigeria. Benue State is located between Longitudes $6^{\circ} 35'E$ and $10^{\circ}E$ and between Latitudes $6^{\circ} 30'N$ and $8^{\circ} 10'N$. Arable land in the State is estimated to be 3.8 million hectares. This State is predominantly rural with an estimated 75 percent of the population engaged in rain-fed subsistence agriculture.

Benue State is divided into three (3) agricultural zones viz: Zone A, Zone B and Zone C. Zone A and Zone B are made up of seven Local Government Areas each while Zone C is made up of nine Local Government Areas. Using a constant sampling fraction of 45%, three Local Government Areas were randomly selected from Zone A and Zone B while four Local Government Areas were randomly selected from zone C. From each of the selected Local Government Areas, one farming community was randomly selected. Finally, from each community, households were randomly selected on the basis of the community's population size using a constant sampling fraction of 1% in order to make the sampling design to be self-weighting thereby avoiding sampling bias (Eboh, 2009). Based on the foregoing, 617 smallholder farm households were randomly selected for the study.

Data were collected mainly from primary sources. The primary data were obtained through the use of structured questionnaires that were administered to the selected 617 smallholder farm households in Benue State.

The P-alpha measure of poverty and the Food Energy Intake (FEI) method were used for the measurement of poverty among the respondents while the Two-Stage Least Squares (2SLS) regression model was adopted for the analysis of the objective of the study. Wald test of linear parameter restrictions was used to test the null hypothesis. The head-count ratio was multiplied by the income gap between the average poor person and the poverty line. This index measures the depth of poverty and is referred to as "income gap" or "poverty gap" measure.

The link between poverty status and poverty reduction among the farming households is indirect through the relationship between productivity, income and poverty. Enterprises that promote income growth and distribution and enhance the revenue of the poor households are most likely to lead to poverty reduction among the poor households. For instance, improvement in farmers' productivity and output would lead to increase in income (all things being equal) and consequently poverty reduction.

Any attempt to view poverty and its relationship among the farming households in Nigeria requires that its interaction among the crucial variables peculiar to the farming households in Nigeria be highlighted. The model therefore, must contain equations explaining the variables and showing their interrelationships. That is, household farm level efficiencies and household poverty status do inter-dependently determine the fortunes of the poor farming households. Therefore a simultaneous equation approach is ideal in the econometric investigation of poverty situation among the farming households in Nigeria.

In comparing the poverty status of the farming households in Nigeria with different farm level efficiencies, allowance must be made for differences in their socio-economic characteristics like family size, farm size, age, farming experience, household expenditure, household food security just to mention a few. This is because such variables have effect on household poverty. Therefore, a number of household characteristic variables were included in the poverty equation.

The structural models therefore, contain household poverty gap equation and household farm level efficiency equation. The models consist of 23 variables, 2 of which are endogenous while 21 are

predetermined. The system is complete in that it contains 2 equations in 2 endogenous variables. Since changes in the variables in the structural equations are very much influencing each other, adopting the simultaneous equation approach will help reduce the incidence of multicollinearity and eliminate the effect of simultaneous equation bias (Koutsoyiannis, 2003). Given the above conditions, the equations of the model were specified as follows:

$$y_{1,t} = \alpha_1 + \beta_2 Y_{2,t} + \gamma_1 X_{1,t} + \gamma_2 X_{2,t} + u_{1,t} \quad (1)$$

$$Y_{2,t} = \alpha_2 + \gamma_1 X_{1,t} + \gamma_2 X_{2,t} + \gamma_3 X_{3,t} + U_{2,t} \quad (2)$$

$t = 1, 2, 3, \dots, n$

where,

$y_{1,t}$ = household poverty gap

$Y_{2,t}$ = vector of household farm level efficiency estimates

$X_{1,t}$ = vector of household income

$X_{2,t}$ = vector of household characteristics variables

$X_{3,t}$ = vector of household farm level efficiency variables

β_s, γ_s and α_s = the parameters to be estimated

$u_{1,t}$ and $U_{2,t}$ = error terms.

3. Results and Discussion

The result in Table 1 shows that at 5% level of probability, the hypothesis that the included explanatory variables have no significant influence on poverty is rejected by the result of the Wald test of joint significance of the parameters, suggesting that there is a significant causal relationship between poverty status and the selected explanatory variables. The model fits the data fairly reasonably. For example, the coefficient of determination (R^2) is 0.8101, suggesting that the model has a high goodness of fit. This indicates that 81.01% variation in poverty status is accounted for by variations in the selected explanatory variables, suggesting that the model has high explanatory power on the changes in poverty status among the respondents. The adjusted R^2 also supported the claim with a value of 0.8031 or 80.31%. This implies that the selected explanatory variables explain the behaviour of poverty status among the respondents at 80.31% level of confidence. The calculated Wald statistic value of 1627.21 which is greater than the critical value of 27.59 at 5% level of significance implies that there is a significant causal relationship between poverty status and the selected explanatory variables.

Furthermore, the result of the study showed that at 5% level of probability, technical efficiency estimates, per capita income, farm size, age, dependency ratio, household members working, household membership of farmer association, household food expenditure, per capita expenditure, access to markets, extension contacts and education have negative and significant influence on the poverty status of the households while allocative efficiency estimates, economic efficiency estimates, total income, transfer income, household size, farming experience, non-food expenditure and gift/tax have positive and significant influence on the poverty status of the households. This suggests that increase in the technical efficiency estimates, per capita income, farm size, age, dependency ratio, household members working, household membership of farmer association, household food expenditure, per capita expenditure, access to markets, extension contacts and education of the households will result to fall in poverty among the households while increase in allocative efficiency estimates, economic efficiency estimates, total income, transfer income, household size, farming experience, non-food expenditure and gift/tax will result to increase in poverty among the respondents.

The implication is that 10 percent increase in the technical efficiency estimates (that is increase from zero towards one, which is the production frontier), will result to 6.02289 percent fall in poverty (and this means that the ratio of total output to total inputs for a farm is rising). This implies that as average productivity increases poverty decreases, suggesting that output is being maximized from a given quantum of inputs. In addition, 10 percent increase in per capita income, farm size, age, dependency ratio, household members working, household membership of farmer association, household food expenditure, per capita expenditure, access to markets, extension contacts and education of the households will result to 0.00002, 0.22213, 0.03569, 0.27997, 0.12431, 0.39443, 0.00036, 0.00002, 0.02745, 0.01502 and 0.01313 percent fall in poverty respectively among the smallholder farmers in Benue State within the study period.

Furthermore, 10 percent increase in the allocative efficiency estimates (that is increase from one, which is the cost frontier towards infinity), will result to 3.41872 percent increase in poverty (and this means that the ratio between total cost of producing one unit of output using actual factor proportions in a technically efficient manner and total cost of producing one unit of output using optimal factor proportions in technically efficient manner is rising). This implies that as the cost of technical efficiency increases poverty increases, suggesting that production cost is not being minimized. Similarly, 10 percent increase in the economic efficiency estimates (that is increase from one, which is the economic frontier, towards infinity), will result to 3.63872 percent increase in poverty (and this means that the costs per unit of output for a farm is rising). This implies that as the cost of maximizing output increases poverty increases, suggesting that profit is not being maximized. Furthermore, 10 percent increase in total income, transfer income, household size, farming experience, non-food expenditure and gift/tax will result to 0.00001, 0.0001, 0.28939, 0.02685, 0.000001 and 0.00002 percent increase in poverty respectively.

TABLE 1:TWO-STAGE LEAST SQUARES ESTIMATION RESULTS OF THE POVERTY STATUS DETERMINANTS AMONG THE RESPONDENTS

Variable	Estimate	t-ratio
Constant	1.050841	2.747
Technical efficiency estimates	-0.602289	-1.808*
Allocative efficiency estimates	0.341872	1.579**
Economic efficiency estimates	0.363872	1.943*
Total income	0.000001	7.415**
Transfer income	0.000010	2.755**
Per capita income	-0.000002	-7.323**
Farm size	-0.022213	-4.257**
Household size	0.028939	5.992**
Age	-0.003569	-3.283**
Farming experience	0.002685	2.574**
Dependency ratio	-0.027997	-3.827**
Household members working	-0.012431	-1.500*
Household membership of farmer association	-0.039443	-3.061**
Household food expenditure	-0.000036	-33.539**
Non-food expenditure	0.0000001	2.337**
Per capita expenditure	-0.000002	-4.322**
Access to credit	-0.003708	-0.211
Total value of output	-0.0000001	-1.292
Gift/tax	0.000002	2.056**
Access to markets	-0.002745	-1.709*
Extension contacts	-0.001502	-2.191**
Education	-0.001313	-1.782*
R-square	0.810115	
Adjusted R-square	0.803082	
Wald statistics	1627.21***	

Source: Field Survey, 2010.

**t-ratio is significant at 1% level of significance.

*t-ratio is significant at 5% level of significance.

***Wald statistic is significant at 5% level of significance.

All the variables satisfied their respective *a priori* expectations except total income, transfer income and farming experience. The deviation of total income and transfer income from the *a priori* expectations is attributable to inequitable distribution of income among the respondents. Sawada and Estudillo (2006) observed that inequality tends to increase poverty. Asogwa *et al.* (2010) found that high degree of inequality exists in the distribution of income among the rural and peri-urban farming households in Nigeria,

suggesting that income redistribution policy can lead to a considerable reduction of poverty among the respondents.

Inequality in farm income among the respondents can be attributed to inequality of access to farm inputs. According to Hobswan (1973) and Aigbokhan (1988), the peasant farmers constitute a politically weak segment of the population, and as a result governments tend to identify the more politically strong components of this group and direct policies to and through them for patronage. Consequently, with a relatively small population of farmers (the progressives) being in planning and plan implementation, the differential effects of benefits from planning would therefore affect the structure of inequality by increasing it. Inequality in non-farm income among the respondents is due to the fact that farmers differ greatly in their relative access to income generation from non-farm sources. Mikloda (2006) and Asogwa *et al.* (2010) observed that non-farm income increases inequality.

The deviation of farming experience from the *a priori* expectation can be attributed to inefficiencies in the use of resources associated with the small farms. According to Reddy *et al.* (2004), greater efficiencies in the use of resources are associated with the large farms than the small farms. The smallness of holdings deters the use of mechanization and does not allow the use of modern inputs due to lack of purchasing power in the hands of small farmers. This explains why the poverty status of the farmers increased as their years of farming increased.

The study showed that a unit increase in economic inefficiency is seen to generate the highest rise in poverty among the respondents. This suggests that household overall economic efficiency (which measures the ability of a farmer to maximize profit) is most critical for reducing poverty among the respondents.

The policy implication of the foregoing finding is that any policy that is directed towards improving the respondents' farm efficiencies, scale of production, per capita income, food security, organization of farmers into collective farmers' institutions and household income distribution would go a long way in reducing poverty among the respondents. Furthermore, increase in employment opportunities of the farming households, increase in farmers' access to markets, availability of extension services and increase in the access of farmers to higher education would no doubt reduce poverty among the respondents.

4. Conclusion

In conclusion, improvement on the respondents' farm efficiencies, scale of production, per capita income, food security, organization of farmers into collective farmers' institutions and household income distribution would go a long way in reducing poverty among the respondents. Furthermore, increase in employment opportunities of the farming households, increase in farmers' access to markets, availability of extension services and increase in the access of farmers to higher education would no doubt reduce poverty among the respondents.

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